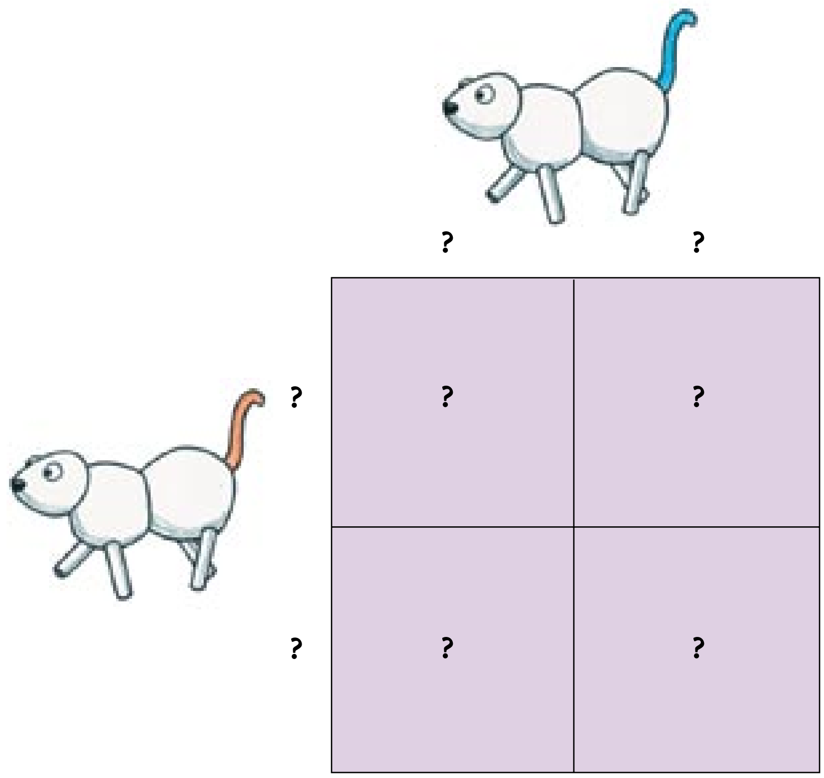
61 Gene Squares

PROBLEM SOLVING

In previous activities you learned that each offspring receives half of its genes from one parent and half from the other parent. You also learned that different versions of a gene are called alleles. You used coin tosses to model the way alleles are passed from parents to offspring. You observed that each offspring received two alleles, one from each parent. In the simulation to determine tail color, if one parent contributed a blue tail-color allele (**T**), and the other parent contributed an orange tail-color allele (**t**), the allele combination was **Tt**. This is a critter's **genotype** (GEEN-oh-type) for that characteristic. Because the allele for the blue tail color was dominant, the physical appearance of the tail was blue. We call this the critter's **phenotype** (FEEN-oh-type) for the characteristic. In this activity you will learn how a table, called a Punnett (PUN-it) square, can help you predict the genotypes and phenotypes in a breeding experiment.



CHALLENGE **How can Punnett squares help you predict patterns of inheritance?**

MATERIALS

For each student

1 **Student Sheet 61.1, "Punnett Squares—Step by Step"**

PROCEDURE

Read "How to Use Punnett Squares," and then complete the Punnett squares on Student Sheet 61.1.

HOW TO USE PUNNETT SQUARES

A **Punnett square** is a diagram you can use to show the likelihood of each outcome of a breeding experiment . It is used when each parent's genes for a trait are known. By filling in the squares, you can find the possible genotypes of the two parents. You can also predict the chances that each phenotype will occur.

Consider the cross between Skye and Poppy as an example. The two phenotypes for tail color are blue and orange. As you modeled in Activity 58, "Creature Features," there are two versions of the tail-color gene, one for blue and one for orange. These two versions are called alleles. As you saw in Activity 59, "Gene Combo," the blue allele is written as uppercase **T** and the orange allele as lowercase **t**. This is because we know that blue tail color is dominant to orange. (You might also use **B** for blue and **b** for orange, since blue is the dominant trait. But you need to use the same letter, uppercase and lowercase, for the two alleles of any one gene. To avoid confusion, always remember to underline the uppercase letter.)

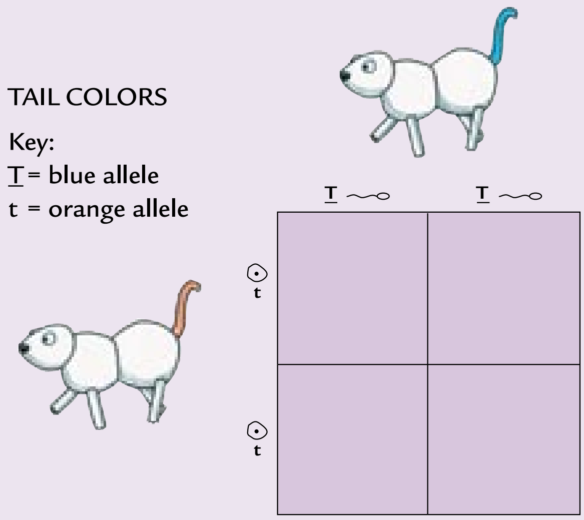
Because Skye is from an island where there are no orange-tailed critters, we can assume he has only blue tail-color alleles. So, his genotype for tail color is **TT**. Because Poppy is from an island where there are no blue-tailed critters, we can assume she has only orange tail-color alleles. So, her genotype for tail color is **tt**. An organism that has only one kind of allele for a characteristic is called **homozygous.** Skye is homozygous for the blue tail-color trait, while Poppy is homozygous for the orange tail-color trait.

STEP 1:
Starting a Punnett Square

Every Punnett square should have a title, four boxes, the genotypes of the parents' traits listed at the left side and the top of the square, and a key.

Write the possible alleles donated by each parent along the top of the table and left side of the table—it doesn't matter which parent you use for each position. In the table below, Skye's alleles are placed along the top and Poppy's at the left.

Each **T** along the top represents an allele in the sperm cell produced by Skye. Each **t** on the left represents an allele in the egg cell from Poppy.



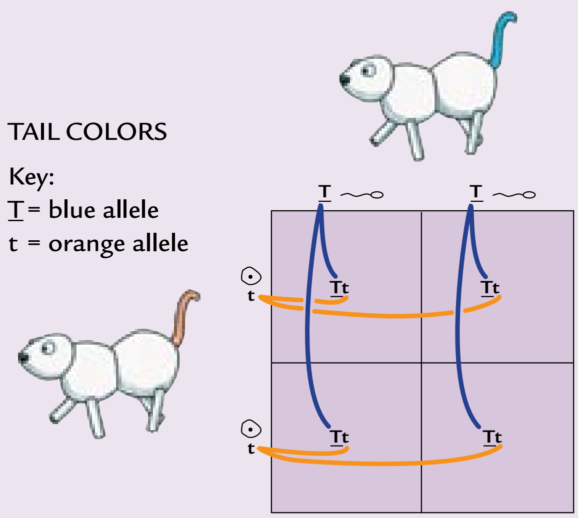
STARTING A PUNNETT SQUARE

Remember: an underlined uppercase letter is used for the allele for the dominant trait. A lowercase letter is used for the allele for the recessive trait.

STEP 2:
Completing a Punnett Square

Complete each box of the table by combining one allele from the top and one allele from the left, as shown below.

When you combine one allele from each parent into a box, you are representing a sperm cell fertilizing an egg.



COMPLETING A PUNNETT SQUARE

STEP 3:
Making Conclusions Using a Punnett Square

Now you can use the Punnett square to make some conclusions. All of the offspring of Skye and Poppy will have one allele for blue tail color and one allele for orange tail color. Their genotypes will be Tt. An organism that has alleles for two different traits is called **heterozygous.** Because blue tail color is dominant over orange, the phenotype of all offspring is blue tails, as found in the breeding experiment between Skye and Poppy.

ANALYSIS

1. Compare the results of your Punnett square for Problem 1 on Student Sheet 61.1 with the results of the Ocean/Lucy cross in Activity 59, "Gene Combo." Why are they similar?

2. Refer to the table of Mendel's results in Activity 60, "Mendel, First Geneticist," on page D-36.

   a. What are the traits for pea flower color? Suggest letters you might use to represent the alleles for flower color.

   b. What are the traits for seed surface? Suggest letters you might use to represent the alleles for seed surface.

3. Review your results on Student Sheet 61.1. Why is it impossible for offspring to show the recessive trait if one parent is homozygous for the dominant trait?

4. A scientist has some red-eyed fruit flies. She knows that red eyes are dominant over white eyes in fruit flies. She wants to find out if the fruit flies she has are homozygous for the red eye color.

   a. What cross will be best to find out if the red-eyed fruit flies are homozygous?

   b. Use Punnett Squares to show what will happen if the red-eyed fruit flies are crossed with white-eyed fruit flies when:

      i. the red-eyed fruit flies are homozygous.

      ii. the red-eyed fruit flies are heterozygous.

EXTENSION

Draw Punnett Squares for Generation 1 and Generation 2 of Mendel's pea plant experiments as listed in Table 1 of Activity 60. Did Mendel's results match your predictions from the Punnett Squares?